G. Proposal to the California Public Utilities Commission (Draft)

Electricity From Landfill Gas And Other Biogas;
Climate Active Gas Mitigation In Utility Restructuring

Ad hoc subgroup on Biogas, and ad hoc subgroup on Climate Active Gases[1]

Preface

This proposal specifically addresses renewable electricity from biogas as an avenue to reducing climate active (or "greenhouse") gas emission in the restructured electric utility industry.

The proposal is intended to serve as an adjunct to any of the other candidate proposals from the ad hoc renewables working group which address the wider range of restructuring issues connected to the proposed Renewable Energy Credit.

1. Abstract

Electric power fueled by biogas, from landfills and other sources, already amounts to about 200MWe in California, with its potential several-fold higher. Capture and energy use of biogas substantially reduces emissions of methane to the atmosphere. Because methane's greenhouse potency is equivalent to over 20 times its weight of carbon dioxide, electricity from biogas has benefits in climate change mitigation exceeding those of other renewable energy sources. Landfill gas use, alone, could offset by 10% or more total greenhouse gas (mainly CO_2) emissions by the California electric utility industry.

Consideration and promotion of renewable electricity climate benefits is consistent with California and federal policies, and international treaties (the "Rio Convention"). Nearly all California utilities are signatories to the voluntary U.S. Climate Challenge Program, to reduce climate active gases. This proposal presents an approach to include the specific climate benefits of biogas utilization into the proposed Renewable Energy Credit (REC). The mechanism involves a subsidiary component of the REC--the Greenhouse Environmental Credit (GEC). The GEC allows technologies providing higher climate change benefits to receive expanded credit. Credit would apply specifically to electricity from landfill and other biogas sources, much or all of whose methane would otherwise escape into the atmosphere. Whenever greenhouse gas mitigation (fossil CO_2 offsets) can be obtained at sufficiently low cost (by criteria herein) it is proposed that electricity from biogas

[1] June 11, 1996. Supporting and contributing organizations: City of San Diego; Monterey Regional Waste Management District (representing Monterey County); International Power Technology; Institute for Environmental Management. Other participants to be listed, subject to their further review. See May 3 biogas position paper for earlier contributors/participants.

be allowed to expand independently, without affecting other renewables' uses. We propose and justify, for landfill and other biogas, a value for the GEC equivalent to an additional REC, and propose mechanisms for its implementation.

2. Interpretation of Commission Goals; Relationship of this Proposal to Commission Goals in Restructuring

The CPUC, in its Restructuring Decision of December 20, 1995, commits to fostering electricity from renewable resources. The commission's decision clearly allows for strong roles for diverse renewables, including wind, solid biomass, geothermal energy, photovoltaics, solar thermal, and others.

One renewable energy resource already significant in California is electricity fueled by "biogas" derived from the decomposition of various organic wastes. This document first discusses the current and potential future role of renewable electricity from biogas within the restructuring industry. The purpose is to provide an overview of the status, and particularly the existing environmental issues, with electricity from biogas. It then proposes an approach to maximize climate change benefits from electricity from biogas within a restructured industry. Restructuring implications of the approach are presented.

3. Program Background, Overview and Description

a. Electricity from Biogas in California

Methane rich gas, ("biogas"), is produced by microbial decomposition of organic wastes including municipal solid wastes, manures, and sewage sludges. In this document, biogas is considered to include all methane-rich gas generated by microbial action from existing wastes, whether in landfills, or anaerobic digestion of manures, sewage sludges, and other wastes such as from food processing. Such biogas can and does already fuel electricity generation in a variety of commercial equipment, with present prime movers including internal combustion (IC) engines, combustion gas turbines and steam turbines.

Somewhat over 200MWe of net capacity are (or shortly will be) fueled by biogas in California. The largest category (over 80%) of biogas-based generation is at municipal waste landfills, from "landfill gas" (LFG). From statistics developed in cooperative solid waste industry/USEPA-sponsored work, present and contracted generation capacity of the landfill gas industry in California is as shown in Table 1. Electricity from the anaerobic digestion of sewage sludge and food waste may be about 15-25 MWe and from manure biogas is presently under 2MWe. The electricity from biogas is nearly all baseload (85% or greater annual capacity factor) as biogas, which is non-storable, is typically collected 24 hours/day.

TABLE 1. LANDFILL GAS ELECTRIC GENERATION IN CALIFORNIA

(Net megawatt capacity at site; typical sites average 85% [or more] of net capacity annually) (Source: Thorneloe and Pacey, 1996, Kennelly, 1996)

SITE	NET CAPACITY, MWe
Altamont, Contra Costa County	5.0
American Canyon, Solano County	1.55
Austin Road,	0.75
BKK-1, Torrance,	3.4
BKK-2, Torrance	6.4,
Central of Sonoma County,	6.0
Central of Yolo County	1.8
Corona	2.0
Coyote Canyon, Los Angeles County	12.0
Crazy Horse, San Luis Obispo County	1.28
Guadalupe, Santa Clara County	2.5
Marina, Monterey County	1.9
Marsh Road, Santa Clara County	2.0
Mountain View, Santa Clara County	3.0
Newby Island, Santa Clara County	4.0
Olinda, Los Angeles County	5.0
Oxnard Ventura County	5.25
Otay, San Diego County	3.4
Palo Alto, Santa Clara County	1.2
Palos Verdes, Los Angeles County	7.0
Penrose, City of Los Angeles	8.5
Puente Hills, Los Angeles County	47
San Marcos, San Diego County	1.32
Santa Clara, Santa Clara County	1.42
Santa Cruz, Santa Cruz County	0.66
Spadra, Los Angeles County	9.0,
Sycamore Canyon, San Diego County	1.32
Temescal Road,	1.31,
Toyon Canyon, City of Los Angeles	8.5,
West Contra Costa, Contra Costa County	2.6.
	Total 157.1
CAPACITY UNDER DEVELOPMENT (BINDING CONTRACTS)	
Lopez Canyon, Los Angeles	12
Marina addition (Monterey County)	1.0
Mid-Valley	6.0
Millican	6.0
Miramar, San Diego County	6.4
Prima de Secha, Orange County	6.0
Kiefer Road, Sacramento County	10
South Cholla	1.6
Total	49
Whittier, Los Angeles County, in negotiation	TBD
Ox Mountain, San Mateo County, in negotiation	TBD

b. Electricity from Biogas, Atmospheric Methane Emission, and Climate Change

Renewably based electricity is designated a "public purpose" program by the CPUC. One major public purpose justification for renewables is environmental benefits accruing from their use. One environmental benefit of renewables, now seen as extremely important, is addressing climate change by reduction or mitigation of the emission of climate active gases. Mitigation of climate change and climate active (i. e. "greenhouse") gas emissions has become a major state, federal and international concern, as well as the subject of a major international agreement[2]

In brief, recovery and use of biogas for electricity generally provides corresponding reductions in emissions of methane to the atmosphere, as discussed in more detail in subsequent sections and notes. Conversely, without biogas energy uses, major sources of biogenic methane emission escape control either partially (landfills) or entirely (manures)[3]. As a "greenhouse" gas, methane's potency on a weight basis is over twentyfold that of carbon dioxide. Thus capture and use of biogas from these sources helps substantially in addressing global warming. Reduction in methane emissions also addresses other adverse phenomena, particularly stratospheric ozone depletion. Most relevant for the electric utility sector, methane emission mitigation resulting from biogas-to-electricity provides uniquely large per-kilowatt "offset" to otherwise adverse greenhouse effects of fossil CO_2 emission from electric power generation. Fueling an estimated potential of 600MWe or more of California electricity with biogas will offset about 10% of the fossil CO_2 emissions associated with electricity generation in California (further discussion in Note A-1)

c. Recognition of Biogas Benefits

The climate change benefits of electricity from biogas are well-recognized by the electric utility industry and utility trade organizations. (Note A-2). These climate change benefits are also recognized and promoted in an array of government programs and initiatives (Note A-3). As but one example, four (of 50) action items in the 1993 Presidential Climate Change Action Plan deal with energy uses of biogas.

The Intergovernmental Panel on Climate Change (IPCC) working value for methane's greenhouse potency is about ninefold that of CO_2 on a molecule-for molecule basis, or a factor of 24.5 higher than carbon dioxide on a weight basis; (these values are also used by the

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[2]The United States is signatory to the Rio Treaty, (Framework Convention) wherein it has agreed to actions to ensure that greenhouse gas emissions in the year 2000 do not exceed 1990 level. It is very likely that the U.S. will be in violation of this treaty condition by 2000.

[3] Even with numerous extant air emission regulations, no statutes or regulations (local, state, or federal) address atmospheric methane emissions per se; methane abatement instead subordinates to control of other biogas components (VOC's). Unless air pollutant emissions dictate control under statutes, major emitters of methane may escape control entirely.

U.S. EPA and United States Department of Energy [DOE]) Based on this, generation of one kWh from biogas as opposed to its emission to the atmosphere effectively offsets carbon dioxide emissions from about 10kWh of fossil fueled power[4].

This CO_2 mitigation or "offset" associated with electricity from biogas is well-accepted. It is quantified and reported by nearly all U.S. utilities purchasing and reselling electricity from biogas, as well as their trade organizations. The most active electric utility trade organizations on this issue are the Edison Electric Institute, (EEI), representing Investor Owned Utilities (IOU's), and the Electric Power Research Institute (EPRI). Greenhouse gas mitigation programs of utilities and others are reported under the U. S. Department of Energy's Title 1605 (b) voluntary reporting program for greenhouse gas mitigation efforts. Under the program, methane use reported with electricity from biogas is all taken as equivalent to abating 24.5 times its weight in CO_2 (the standard IPCC/EPA/DOE methane greenhouse value).

d. Monetary Valuation and Cost Effectiveness of Biogas Climate Benefits

Methane greenhouse gas mitigation can be valued monetarily in terms of what certain U.S. utilities are already willing to pay for the greenhouse gas offsets (Note A-4)[5]. Calculated valuations range from 1.4 to 7.5 cents/kWh. Such valuations are for greenhouse gas abatement at $10-20/(US ton CO_2 carbon) or $2.75-5.50/ton CO_2. Though there are no "standard" valuations for greenhouse gas reductions, these represent costs at the very low end of the spectrum of fossil CO_2 abatement costs. As discussed, biogas use for electricity does generally result in net abatement of atmospheric emissions and, so, represents net "public good" in terms of not only the greenhouse gas but also VOC offsets (Notes A-4 and also A-5).

e. Current Economics and Status of Biogas

Though climate change benefits from biogas to electricity are widely and officially recognized, markets for electricity to grids have been sufficiently adverse, or uncertain, that most biogas from landfills and other wastes still does not find use. Survey work (Thorneloe and Pacey, 1994) has indicated that, as of 1994, only about 300 MWe of landfill-gas-based generation were realized in the U.S. out of a U. S. potential estimated by both the U.S. EPA (EPA 1993) and the Electric Power Research Institute (EPRI, Gauntlett, 1992) to be 5000-7000MWe[6]. Part of the problem, noted above, is that landfill regulations address only local air pollutants. There is also no direct regulatory authority, or monetary incentive to prevent

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[4] Ninefold offset from methane abatement plus backing out CO_2 from one kWh of fossil power generation. As noted briefly in A-1, it is nearly all fossil fueled power that is displaced by renewables.
[5] Note A-4 of this proposal examines carbon abatement values of $10 and $20/U.S. ton. In California, carbon abatement values of $30/ton are considered (Electricity report docket 93-ER-94, June 7, 1994)
[6] Potential in EPA and EPRI refs based on size criteria (>1MWe) and presuming favorable power markets.

biogas' greenhouse methane emissions per se to the atmosphere. Another major barrier is economics. Electric power development from many landfills and manure streams--that now emit a great deal of methane to the atmosphere--is more expensive than electric revenues of themselves would justify. This is because of small scale and many other site-specific factors. Combinations of uncertainties and costs have been such that, even with past favorable SO4 electricity purchase prices (applicable in some cases), and past tax credits[7], electricity from landfill gas in California developed only about 150 MWe out of gross potential of perhaps 500-700 MWe (for estimate basis see Note A-6). For biogas from manure, percentage of methane recovered to generate electric power is much less than 1% nationwide (Roos, 1995).

Another issue arises as the California electricity industry restructures. In states where utilities remain integrated, and subject to states' Public Utility Commissions' controls, it has proven possible for such integrated utilities to undertake greenhouse gas and biogas abatement projects through commission directives (e.g. Minnesota, Massachusetts). With present restructuring in California, it is not clear what entity might have responsibility for additional greenhouse gas abatement efforts, beyond those consequent to application of the REC's as now envisioned. To address this situation, a possible approach, developed below, is to adapt REC's to accomplish additional desirable climate active gas abatement.

f. Statutory Authority to Value Emission Abatement

As noted in several other Renewables Working Group proposals addressed to the CPUC, there exists statutory authority to value environmental benefits of specific generating technologies. The California Public Utilities Code states**:**

> -In calculating the cost effectiveness of energy resources, the Commission is directed to include a value for any costs and benefits to the environment, including air quality [sect 701.1 (c)]

g. Greenhouse Environmental Credit (GEC)

Significant monetary values are estimated for environmental benefits for electricity from biogas (Note A-4). Statute allows these values to be recognized in electric power generation. Thus we propose that environmental benefits, including greenhouse gas and VOC abatement, be reflected by a credit, applied where biogas capture mitigates emissions to the atmosphere[8]. This credit is provisionally termed a Greenhouse Environmental Credit, ("GEC") assigned

[7]Federal section 29 tax credits effectively provided about 1 cent/kWh to electricity from most LFG projects under binding contract by the end of 1995. Credits will no longer be available for new projects.

[8] Applying for example, to manures, landfills and certain sewage and food processing wastes. Excluded from credit, however, would be de novo fermentations of non-waste harvested feedstocks "for biogas"(as for example grasses grown especially for conversion to biogas). These provide no added greenhouse gas mitigation beyond that available from other renewables, thus merit no additional credit.

each kilowatt generated from biogas[9]. This would value environmental benefits in accordance with statute, with emphasis to the severalfold greenhouse gas abatement compared with other renewables.

Of course, any valuation such as via the proposed GEC raises questions. The principal question is, what total per-kWh value of a renewable, as related to other benefits, should be assigned to global climate benefits? Monetary valuations of "externalities" are inherently imprecise, having subjective "value judgment" components[10]. However almost all arguments in favor of renewables emphasize the same basic components--global change, regional/local air pollution, sustainability, and domestic/local production. If equal weighting were to be assigned to each factor, a ninefold higher climate change benefit should translate to a threefold higher REC value for electricity from biogas compared to other renewables. Even recognizing that some degree of control will take place, for certain wastes, under existing regulations, additional monetary incentives for any additional biogas used for energy would achieve much additional control. Substantial value for the GEC is thus justified by the additional offset. Here we propose the GEC for electricity from biogas be set equal the REC for other renewables. This would reflect a premium of 100%, as biogas would receive a total of 2 REC's per kWh generated from it. For expected values of the REC, this would result in a premium paid for biogas kilowatts (ca. \$0.02/kWh or about \$3.75/ton CO_2) that is reasonably reflective of "extra" payments in fact made by utilities elsewhere in the U. S. today, for CO_2 offsets in a range of projects.

Certainly, the value of greenhouse gas abatement may be considered significant, representing a premium of one to several cents/kWh for electricity from biogas, or \$2.75 to 5.50/ton fossil CO_2 abated (Note A-4). The potential value of a biogas electricity premium based on CO_2 abatement is also addressed in EPA, 1993 which arrives at comparable values.

However, to limit costs, we also suggest application of a cost-effectiveness standard for greenhouse gas abatement accruing in association with the GEC. A cost limit is suggested to be \$20/US ton carbon or \$5.50/US ton CO_2 equivalent[11] . The GEC would apply whenever cost for greenhouse gas abatement falls below this limit. If carbon abatement costs are above this limit, the REC alone could apply or other adjustments could be made in its application[12].

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9 This proposal assumes use of a credit-based approach as favored by the CPUC. A surcharge approach could also be workable and we do not wish to imply that it should be precluded.

10 However values can certainly be established by various criteria--see CEC staff papers in connection with docket 93-ER-94 on valuation of air quality benefits

11 Incremental cost would be that of the GEC for power in question, reflecting incremental cost assignable to climate benefit. Corresponding greenhouse gas abatement would be determined by the same rules now used (by entities including all US utilities) for voluntary reporting of greenhouse gas abatement under the U. S. Department of Energy's 1605 (b) Voluntary Reporting Program for greenhouse gas mitigation efforts.

12 Alternately, cap GEC value (in terms of its REC equivalent) such that the cost standard is still met over specified intervals. A cap could also address other problems, as from variable REC monetary value.

h. Issues with the GEC

This assignment of increased REC (i. e., via the GEC) to reflect the climate and pollutant benefit associated with biogas use raises several issues and questions, discussed next. These include (1) administration, (2) that biogas kilowatts would presumably receive more payment per kWh than is received by other renewables, (3) that biogas kilowatts could possibly adversely affect (or "squeeze out") desirable use of other renewables, (4) rather than assigning electricity from biogas what is in effect a higher REC value per kilowatt, why not "band" biogas, giving it a substantial setaside as proposed for certain other renewables? and (5) is this approach fair to ratepayers? We discuss each of these**:**

For (1)**:** Administration could certainly become complex if GEC's were to be handled independently from REC's. As implied above, we suggest the administrative complexities with the GEC for biogas be minimized by tying it to the REC and handling it exactly as REC for convenience. This should minimize incremental administrative work.

In the future, however, the GEC might be treated separately and traded independently from the REC. An important feature of greenhouse gas abatement is that it has the same value to the world's environment regardless of where in the world the greenhouse gas abatement occurs. Thus such credits might easily have value and be traded nationally, or even internationally.

(2) The resultant higher sales price likely for electricity from biogas via a Greenhouse Environmental Credit is, in any event, paralleled by the treatment already requested for solid fuel biomass, as well as for pre-commercial technologies. Solid fuel biomass is requested in both AWEA and IEP proposals to be "banded", i.e. to receive a setaside such that most existing solid fuel biomass plant remains or is brought online. (This is also embodied in the legislative approach of AB1202.) It is expected by IEP and AWEA that this will result in higher costs for solid-biomass-fueled power. For solid fuel biomass the justifications listed by AWEA for higher cost and keeping solid-fuel-biomass plants online include (a) waste diversion from landfills (b) prevention of open agricultural burning and (c) forest management benefits. (a bringing indirectly, and b bringing directly, environmental benefits that should be valued consistent with utilities code [sect 701.1 (c)] above) In the case of electricity from landfill and other biogas, the environmental benefits valued consistent with utilities code sect 701.1 (c) are instead simply the increased mitigation of climate active gases--and VOC's in addition (again refer to Note A-4).

In the CEC Technical Development Division (CEC-TDD) staff proposal, higher purchase prices are also advocated for technologies in early (i. e., pre-commercial) stages of development**;** the higher sale prices would obviously help these toward commercialization. This is another case of higher prices for certain renewable categories, for purposes considered beneficial.

(3) We propose biogas to electricity should be able to increase without adversely affecting or diminishing use of other renewables. The climate active gas mitigation with electricity from biogas is public good of high importance (internationally, inasmuch as climate change is an international issue). It is directly relevant to, and offsets, adverse global impacts of the electric utility sector. There appears no convincing reason that increased biogas use, as justified by added climate benefits, should result in diminished use of other renewables with their corresponding benefits. Providing greenhouse gas abatement meets stated cost-effectiveness criteria, it is proposed here that total allocated REC's should be increased by whatever amount is necessary to accommodate all electricity from biogas (the biogas REC total including the GEC equivalent). In any case, REC's for, and total production of, other renewably based electricity should remain the same as they would be absent electricity from biogas. This treatment can assure that other renewably based generation is not affected.

(4) For solid-fuel biomass, generation "banding" proposed by other organizations is slightly less than needed to bring online the totality of operating, shutdown and recent BRPU auction-winning solid-fueled plant capacity. That capacity is well-defined. It is also constrained in ways (fuel supply, costs) that cause costs to escalate relatively rapidly with any added capacity and power production increments above the "band". In the case of biogas, fractional use for electricity is very low. Potential for additional electricity from biogas may be severalfold the existing level (refer to Note A-6).

A continuous spectrum of costs is expected for electricity from landfills and other biogas sources, depending on scale and other factors. Incremental additional generation (and greenhouse gas abatement) can be expected to respond elastically to price. "Banding" appears too rigid an approach to address this situation. Uncertainty attends estimates, but the degree to which price might affect generation of electricity and consequent methane (greenhouse gas) abatement with landfill gas is suggested by the figures provided in analyses of EPA (1993). When buyback rates rise from $0.04 to $0.06/kWh, (at a favorable [optimistic] project discount rate assumed in EPA, 1993, at 8%), the resulting electric generation and methane abatement, and equivalent CO_2 abatement more than quintuple for the U.S. At a buyback rate of $0.06/kWh, U.S. landfill methane abatement rises in the year 2000 to 8.2 million metric tons, equivalent (at official IPCC values) to over 200 million U.S. tons CO_2 abated. It is worth noting that greenhouse gas abatement equivalent to 200 million U.S. tons/year of CO_2 constitutes offset to roughly 10 percent of fossil CO_2 emissions of the U.S. electric utility sector annually--and this is for landfill biogas alone. It is also worth noting that electricity from manure biogas has a wider and generally higher spectrum of costs (EPA, 1993, Sharp, 1996); manure methane is estimated to have total climate change impact about 30-50% that of landfill gas (see data of EPA, 1993, Whittier, 1994). It would be expected to have similarly significant price response in terms of power generation and greenhouse gas abatement.

In any event, whatever incremental electricity from biogas does come online in response to price will result in further GHG and VOC offsets, thus public benefit. The allocation of two RECs per biogas kilowatt--via GEC's--lets this resource and its corresponding benefit or corresponding "public good" expand elastically to the extent that it can in response to price. The biogas electricity price premium can be justified on cost/benefit criteria developed on the basis of costs for abating emissions (Note A-4).

At the same time the cost obligation with the GEC approach is not open-ended: First, tying the GEC to the REC determines GEC value in turn by the same competitive factors determining REC value in an active market. Also the eligible biogas-from-waste resource constrains maximum generation to less than 3% of California electricity (likely, about 2%). Finally, as noted, a cost-effectiveness standard can be applied in terms of an upper limit to greenhouse gas abatement cost. It must be emphasized that the overall intent is to apply the GEC to mitigate climate impacts, limiting GEC scope and application to situations where it provides the most cost-effective abatement of climate active (and pollutant) biogas emissions.

(5) A general, certainly major issue with monetization of renewables' environmental, and other benefits--that of fairness**:** Is it fair to charge premium costs for landfill and other biogas and other renewably based power which are passed through to ratepayers?

The utility sector, and ultimately ratepayers, bear responsibility for greenhouse gas emissions. Thus electricity user support of renewable and biogas-based power as discussed here appears as fair as any mechanism to offset environmental and other impacts of electric power production. As noted earlier, one advantage of electricity from biogas for ratepayers is that it is among the most "greenhouse-cost-effective" of CO_2 emission offsets, per kWh. Even at twice the REC subsidy, the ratepayer still gets much cheaper greenhouse gas abatement than with other technologies.

A comment here is that we support the California Energy Commission staff proposal for higher revenue tier for pre-commercial technologies in earlier stages of development. Electricity from manure biogas has significant potential but remains in early development with probably less than 2MWe nationwide, and likely less than 1MWe in California. Manure biogas in particular is a present major source of greenhouse methane in the U.S. A band in which electricity from manure biogas receives higher revenue--possibly by additional RECs beyond the extra from the GEC is appropriate.

i. GEC operation

An RPS standard could require that (for example) 10% of total California electricity generation could be met by renewables, aside from biogas. If biogas eligible for the GEC were to provide an additional 1% of total California electricity generation then the RPS would expand to accommodate biogas-based generation. The RPS would require purchase of power or RECs equal to 12% of generation, i.e., the 10% of other renewables + 2% representing the biogas REC + GEC. (In meeting the portfolio standard biogas based power usually would via the GEC + REC, either count twice, or give rise to two REC's.) This renewables (or equivalent renewable credit) obligation would accrue pro rata to all UDCs (or whatever entities must meet the renewable portfolio obligation according to portfolio standards).

Allocation of 2 REC's per biogas kilowatt via the GEC as opposed to one per other renewable kilowatt, could operate as in the following simplified examples.

1. If (as another example) the RPS were for 15% renewable energy or credits in the mix, the REC credit need would actually be met by purchase of 10% other qualifying renewables plus 2.5% of the electricity from biogas (thus, 5% of power credited from biogas).

2. If a customer in a bilateral agreement were to purchase 100% of electricity supply needs from biogas, and a GEC = 1.0 REC, then renewable energy credits would amount to 200% of those kilowatts. In an active market characterized by many buyers and sellers, it would be expected that extra REC's would accrue value which could return to the customer (in a manner similar to other commercial rebates), and that market mechanisms would exist or develop to realize the REC's value for the power customer to the extent desired.

j. Concluding Note

In other aspects this ad hoc biogas and climate active gas working subgroup agrees with and supports several other proposals: the proposals include--but are not limited to--that put forth by the California Energy Commission staff (tier approach to foster renewables in early stages of development) and the joint proposal of the American Wind Energy Association/California Biomass Energy Alliance/Geothermal Energy Association and the proposal of the Independent Energy Producers Association. This proposal is intended to be a suitable adjunct to as wide a range of proposals as possible. In cases where other proposals differ, this group is neutral where it feels differing approaches have merit. This group may later state preference if one exists.

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l. Appendix A--Notes to Overview

<u>Note A-1</u>. <u>Greenhouse Gas/Ozone Loss/Air Pollution Issues</u>:

The generation of power using biogas helps overcome the following problems:

<u>Global warming</u>: Atmospheric emissions of U. S. landfill and other biogas are <u>major</u> factors in global warming, simply because of the enormous quantity of waste and manure, and the climate change potency of methane. In scientific terms, U. S. landfill methane, alone, adds a roughly 1% increment to the total annual increase in radiative forcing due to buildup of all greenhouse gases in the atmosphere (see Augenstein, 1992). In more simplified terms, this means it can be considered responsible for about 1% of the "greenhouse effect". U. S. animal manure impacts from methane emission, are about 30-50% of those from landfill gas (see EPA, 1993, Augenstein, 1992).

<u>Stratospheric ozone depletion</u> Methane--including that from biogas--adds significantly to the recent atmospheric methane buildup. That atmospheric methane buildup has given rise to stratospheric changes which have resulted in turn in the recent sharp losses in polar stratospheric ozone, i. e., the "ozone hole". Stratospheric ozone depletion and the "ozone hole" are now international concerns. (Blake, 1994).

<u>Local air pollution.</u> Landfill and other biogas contains organic pollutants. For landfill gas, these pollutants are the focus of federal, state (California) and local air district rules.

While analyses can easily become extremely detailed, it is possible to simply summarize:

As noted in the text, generation of one kWh from biogas can effectively offset the CO_2 emissions from the order of 10kWh of fossil fueled power. (Capture of one molecule of methane as opposed to emission, offsets 9 CO. Since "swing fuels providing extra incremental power over baseload are nearly entirely fossil, an additional fossil CO_2 or more is displaced by any renewable) Consequently, generation of 1-2% of total electric power with landfill and other biogas, which is the potential in a typical utility service area or state such as California, has "greenhouse effectiveness" equivalent to reducing fossil carbon dioxide emissions by that generation 10% or even more.

The abatement of other gas components (VOC's) has substantial further value as does addressing stratospheric ozone depletion.

<u>Electricity production from biogas can help address all of the stated problems.</u> This is very-well-recognized by electric utilities themselves, utility trade organizations, and government agencies (at all levels). As detailed later below, factors 1 and 2 (climate change) drive U.S.

electric utility conformance with the climate challenge; EPA and Department of Energy programs promote biogas energy uses for these benefits.

Note A-2. Electric Utilities' Positions

The Edison Electric Institute (EEI), the Electric Power Research Institute (EPRI), and numerous individual utilities are taking positions to support or facilitate member utilities' use of landfill gas power (nearly all purchased from IPP's).

EEI (investor owned utilities)--≈ 70% of the investor-owned utilities (in terms of EEI member electric generating capacity) are signatories to the climate challenge. EEI is making sure that all member utilities which use landfill gas electricity take credit for greenhouse gas offsets to the maximum extent possible, reporting methane abatement fully under the DOE 1605 (b) voluntary program to report greenhouse gas abatement.

EPRI supports landfill gas electricity through studies, (see EPRI 1992 reference, this document) and dissemination of information to member utilities. EPRI also supports renewables and greenhouse gas abatement research.

Individual Utilities have long taken interest in electricity from biogas.

Note A-3. Government Agencies' Positions

International, Federal, State and Local agencies endorse objectives met by landfill gas electricity.

International initiatives include the Rio conference, and a number of related international efforts toward renewable energy and greenhouse gas abatement. Other efforts are exemplified by the International Energy Agency (landfill gas expert working group supporting energy uses) and the Intergovernmental Panel on Climate Change (a major working group tracks methane from wastes)

Federal initiatives include the Climate Change Action Plan (CCAP) and Clean Air Act (CAA),   On LFG:

-Under CCAP, USEPA is facilitating landfill gas use via the Landfill Methane Outreach Program (Climate Change Action Plan item # 34) as well as the (related) AgStar program for use of methane from manures (Climate Change Action Plan item # 38).

-Under CCAP, also, the DOE is managing RD&D on methane recovery from landfills (Climate Change Action Item # 37)

-The DOE is also conducting the 1605 (b) voluntary program by which participants report greenhouse gas emission abatement. Nearly all utilities report greenhouse gas offsets (in terms of official CO_2 equivalents above) associated with landfill gas power which they purchase.

State (California) Initiatives include the California Environmental Quality Act (CEQA) those of the California Energy Commission (CEC), California Air Resources Board (CARB) and Waste Board (CIWMB).

Local initiatives include rules in California Air districts.

Note A-4. Economic Factors--Valuing Emission Abatement with Electricity from Biogas.

What is the greenhouse gas abatement value? Many U. S. electric utilities are presently addressing (or willing to address) global warming by projects to either abate or offset fossil CO_2 carbon emissions. This is sometimes in response to utility regulatory commission directives (examples: MN, MA, WI) but has often been voluntary. A number of U.S. utilities have been willing to undertake GHG abatement at costs typically equivalent to $10-20/ton fossil CO_2 carbon abated (or $2.75-5.50/ton fossil CO_2, in the U.S. European abatement and offset processes over twice these stated U. S. costs are under way). On the basis of lower cost U. S. GHG abatement, and knowing generation heat rates and the greenhouse potency of methane, valuations for methane abatement can be calculated. Example calculations summarized in Table 2 (next page) suggest GHG abatement values of $ 0.014 to $ 0.075/kWh for electricity from biogas.

What is the value of VOC abatement? California air rules typically entail cost (thus implied value) of $1.00 to $2.50 per pound of pollutant destroyed. Worth of VOC (air pollutant) abatement be calculated assuming values for landfill gas VOC content and heat rate. These calculations (also in Table 2) show values for air pollutant abatement that might range between 0.28 and 2.1 cents/kWh.

The total of these benefits' calculated value--per kWh generated--is $ 0.017 to 0.096/kWh. All calculations with their basis are presented in Table 2 (next page).

Note A-5. "Public Good" from Biogas-to-Electricity Emission Abatement.

Example calculated values of methane and VOC emission abatement (above) ranged from $0.017-0.096/kWh. These calculations indicate "public good" which accrues with the use of electricity from biogas. Several considerations arise in the evaluation of the degree of "public good"**:**

Some degree of methane and VOC abatement (see further discussion) will occur with LFG because of regulations anyhow, even without conversion to electricity. However the "public good" value per kWh will still exist for nearly all biogas conversion to electricity**.**